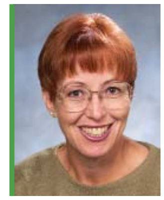
FEA Visualization and Data Management



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One component of our effort is devoted to the ongoing maintenance and enhancement of the GRIZ finite-element postprocessor and the Mili I/O library. GRIZ is our primary tool for visualizing finite-element analysis results on 3-D unstructured grids. The Mili I/O library provides the primary data path between simulation codes and GRIZ.

The value of simulation ultimately rests on how much useful information the analysts can derive from their numerical results. This means visual representations and interrogations of their data. GRIZ calculates and displays derived variables for multiple codes, most importantly DYNA3D and NIKE3D. GRIZ provides modern 3-D visualization techniques such as isocontours and isosurfaces, cutting planes, vector field display, and particle traces. GRIZ also incorporates the ability to animate all representations over time. A variety of simulation data can be passed from the simulation codes using the Mili database representation.

Project Goals

This project's overarching goal is to keep these tools functional and responsive to the needs of LLNL's engineering analysts.

Relevance to LLNL Mission

Our efforts with GRIZ and Mili provide important user interfaces to LLNL's nonlinear solid mechanics simulation capabilities, and facilitate their use by dozens of analysts.

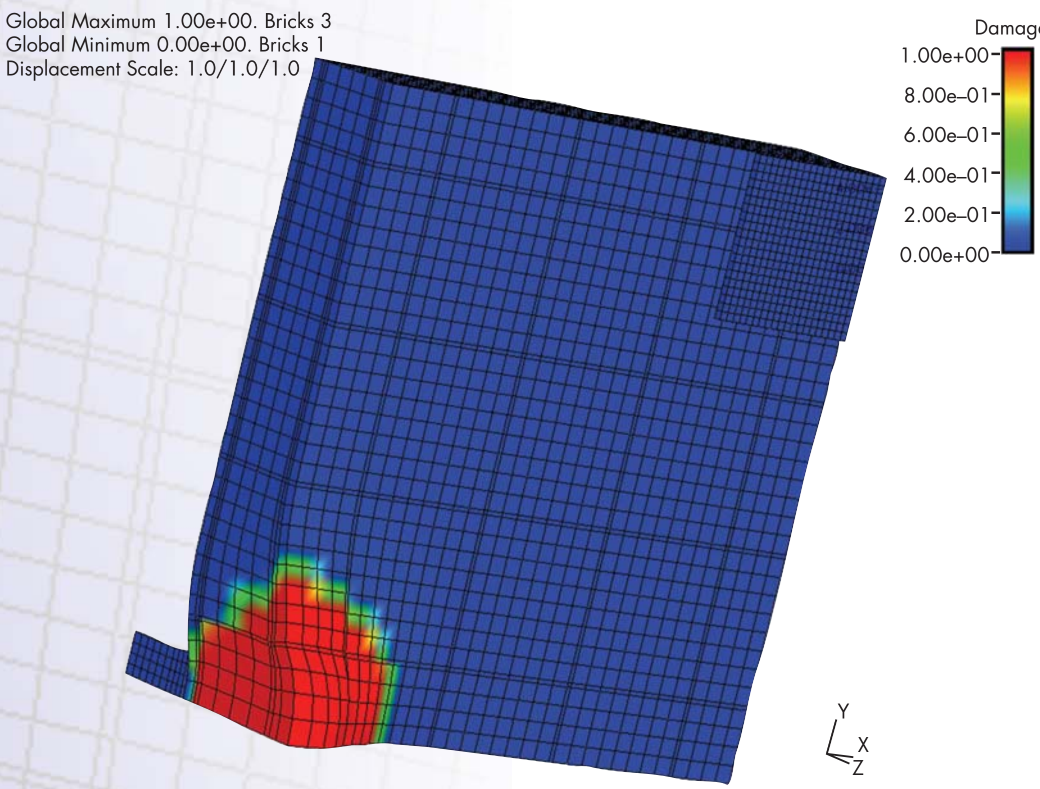

Figure 1. Damage example.

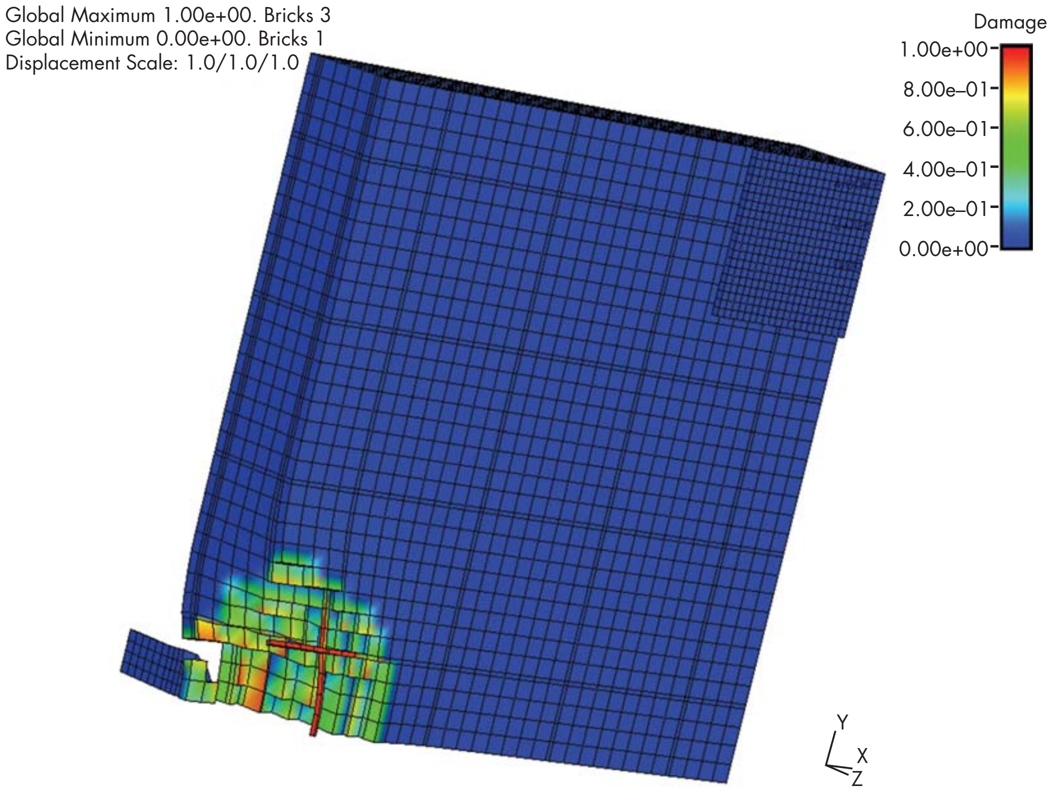

Figure 2. Penetration example with failed material made visible.

FY2004 Accomplishments and Results

In support of homeland security projects, we added a new capability to GRIZ that permits the user to define an evaluation metric that is a function of multiple response quantities. Our initial application was to help interpret the damage to concrete structures as calculated in DYNA3D. The concrete model in DYNA3D uses a damage parameter, d. This parameter goes from 0 to 2, as the failure goes from initial yield to maximum failure to residual failure. This parameter should not be used *by itself* to determine structural integrity. The analyst needs to evaluate other indicators of damage, such as velocity, relative volume, or rebar strain, to get a complete picture of structural failure.

The command for the new result has four parameters: velocity direction, velocity magnitude cutoff value, relative volume cutoff value, and d cutoff value. For each element, a value of either 0 or 1 is assigned, depending on the composite of the average nodal velocity, relative volume, and the value of d. Figures 1 and 2 are examples of this feature applied to a simple, generic penetration problem. In Fig. 1, the elements interpreted as fully failed are colored red. In Fig. 2, these elements are made invisible, permitting visualization of the perforated structure.

A significant enhancement effort in Mili this past year was the implementation of a new surface class capability. This is an essential step needed for facilitating the viewing of boundary conditions and data from the analysis programs on surfaces.

Previously, the analysis programs used artificial (non-physical) shell elements and calculated a new material number for these elements, so that a "surface" could be written to the Mili database and then displayed using GRIZ. The new surface class eliminates such an *ad hoc* approach. The display of surfaces and results on a surface in GRIZ4s will be enhanced with a "surface manager," giving greater flexibility to view results such as boundary conditions and contact pressure information.

FY2005 Proposed Work

Due to the varying demands of user support and user-requested feature addition, our typical planning strategy is to identify a set of logical "next steps" for feature deployment. For next year these features include: completing the surface class capability deployment in GRIZ; addressing prioritized user-requested enhancements; and beginning implementation of Version 2.0 of the Mili I/O library, to support greater flexibility and emerging analysis capabilities like adaptive mesh refinement.